Gulf Cooperation Council

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GSO 59 (1987) (English): INDUSTRIAL SAFETY AND HEALTH REGULATIONS – HAZARDOUS MATERIALS – GASES – PART 5: AMMONIA .

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INDUSTRIAL SAFETY AND HEALTH REGULATIONS – HAZARDOUS MATERIALS – GASES – PART 5: AMMONIA

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INDUSTRIAL SAFETY AND HEALTH REGULATIONS – HAZARDOUS MATERIALS – GASES – PART 5: AMMONIA

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CONTENTS

INDUSTRIAL SAFETY AND HEALTH REGULATIONS – HAZARDOUS MATERIALS – GASES – PART 5: AMMONIA

1. SCOPE AND FIELD OF APPLICATION

This Standard is concerned with the design, construction, location, installation and operation of refrigeration system using ammonia as a refrigerant at any industrial location.

2. COMPLEMENTARY REFERENCES

2.1 GSO 55/1987 "Industrial Safety and Health Regulations – Hazardous Materials – Gases – Part 1: General Requirements".

2.2 GSO 218/1994 "Industrial Safety and Health Regulations - Electrical – Low Voltage".

2.3 GSO 215/1994 "Industrial Safety and Health Regulations – Equipment – Tanks, Pressure Vessels, Boilers and Compressed Gas Equipment".

3. DEFINITIONS

3.1 Absorber (Adsorber): is that part of the low side of an absorption system used for absorbing (adsorbing) vapour refrigerant.

3.2 Absorption System: is a refrigerating system in which the gas evolved in the evaporator is taken up by an absorber or adsorber.

3.3 Companion or Block Valves: Are pairs of mating stop valves, valving off sections of systems and arranged so that these sections may be joined before opening these valves or may be separated after closing them.

3.4 Fusible Plug: A device having a predetermined temperature fusible member for the relief of pressure,

3.5 Generator: Any device equipped with a heating element used in the refrigerating system to increase the pressure of refrigerant in its gas or vapour state for the purpose of liquifying the refrigerant.

3.6 High Side: The parts of a refrigerating system under condenser pressure.

3.7 Internal Gross Volume: The volume as determined from internal dimensions of the container with no allowance for volume of internal parts.

3.8 Limited Charged System: A system in which, with the compressor idle, the internal volume and total refrigerant charge are such that the design working pressure will not be exceeded by complete evaporation of the refrigerant charge.

3.9 Liquid Receiver: A vessel permanently connected to a system by inlet and outlet pipes for storage of a liquid refrigerant.

3.10 Low Side: The parts of a refrigerating system under evaporator pressure.

3.11 Machinery Room, Class T: A room having machinery but no flame-producing apparatus permanently installed and also conforming to the following:

- Any doors, comunicating with the building, shall be approved self-closing, tight-fitting fire doors.
- Walls, floors, and ceiling shall be tight and of not less than one hour fire-resistive construction.
- Each refrigerating machinery room having an area in excess of 10 sq.m and where the maximum possible traveling distance to the exit exceeds 4 m shall have at least two means of egress which shall be provided with tight-fitting doors; also, there shall be no partitions or openings that will permit the passage of the refrigerant to other parts of the building.
- Exterior openings, if present, shall not be under any fire escape or any open stairway.
- All pipes piercing the interior walls, ceiling, or floor of such room shall be tightly sealed to the walls, ceiling, or floor through which they pass.
- Emergency remote controls to stop the action of the refrigerant compressor shall be provided and located immediately outside the machinery room.
- Mechanical means shall be provided for ventilation.
- Emergency remote controls for the mechanical means of ventilation shall be provided and located outside the machinery room.

3.12 Pressure-Imposing Element: Any device or portion of the equipment used for the purpose of increasing the refrigerant vapour pressure.

3.13 Refrigerant: A substance used to produce refrigeration by its expansion or vaporization.

3.14 Refrigerating System: A combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat.

3.15 Absorption System: A refrigerating system in which the gas evolved in the evaporator is dissolved into an absorber or adsorber.

3.16 Sealed Absorption System: A unit system in which all refrigerant - containing parts are made permanently tight by welding or brazing against refrigerant loss.

3.17 Self-Contained System: A complete factory made and factory tested system in a suitable frame or enclosure which is fabricated and shipped in one or more sections, and in which no refrigerant - containing parts are connected in the field other than by companion or block valves.

3.18 Unit System: A self-contained system which has been assembled and tested prior to its installation and which is installed without connecting any refrigerant - containing parts. A unit system may include factory assembled companion or block valves.

3.19 Rupture Member: A device that will rupture at a predetermined pressure.

4. REGULATIONS

4.1 General Requirements

Appropriate provisions of item 2.1 shall be applicable to this item with the exceptions and modifications as noted in this item.

4.1.1 Each appurtenance shall be provided for use with anhydrous amonia.

4.1.2 Design, testing, construction, and marking of the containers shall comply with the Gulf Standard mentioned in item 2.1 and as follows:

4.1.2.1 Containers larger than 91 cm in diameter or 950 litres water capacity shall be constructed to comply with one of the following:

– Containers shall be stress - relieved after fabrication, or

– Cold-formed head, when used, shall be stress - relieved, or

– Hot - formed heads shall be used.

4.1.3 Containers shall be located in accordance with the Gulf Standard mentioned in item 2.1 and as follows:

4.1.3.1 Consideration shall be given to the physiological effects of ammonia as well as to adjacent fire hazards in selecting the location for a storage container. Containers shall be located outside of buildings or in buildings or sections thereof especially provided for this purpose.

4.1.3.2 Permanent storage containers shall be located at least 15 m from a well or other sources of potable water supply, unless the container is a part of a water treatment installation.

4.1.3.3 Storage areas shall be kept free from readily ignitible materials such as waste, weeds, and long dry grass.

4.1.4 Container valves and accessories shall comply with the Gulf Standard mentioned in item 2.1 and as follows:

4.1.4.1 All excess flow valves shall be plainly and permanently marked with the name or trademark of the manufacturer, model number, and rated capacity.

4.1.4.2 Excess flow valves, where required, shall close automatically at the rated flows of vapor or liquid as specified by the manufacturer. The connections or line including valves, fittings, etc., being protected by an excess flow valve shall have a greater capacity than the rated flow of the excess flow valve.

4.1.4.3 Liquid level gauging devices which are so constructed that outward flow of container contents shall not exceed that passed by a 1.5 mm diameter opening need not be equipped with excess flow valves.

4.1.4.4 Openings from container or through fittings attached directly on container to which pressure gauge connection is made, need not be equipped with shutoff or excess flow valves if such openings are restricted to not larger than 1.5 mm diameter opening.

4.1.4.5 Excess flow and back pressure check valves where required shall be located inside the container or at a point outside where the line enters the container; in the latter case, installation shall be made in such a manner that any undue strain beyond the excess flow or back pressure check valve will not cause breakage between the container and such valve.

4.1.5 Piping, tubing, and fittings shall comply with the Gulf standard mentioned in item 2.1 and as follows:

- Threaded connections shall not be backwelded.
- Brass, copper, or galvanized steel piping shall not be used.
- Tubing made of brass or copper shall not be used.

4.1.6 Hose Specifications

4.1.6.1 Hose subjected to container pressure shall be designed for a minimum working pressure of 2354 kPa and a bursting pressure of 11769 kPa. Hose assemblies shall withstand a test pressure of 3531 kPa.

4.1.6.2 Where hose is to be used for transferring liquid from one container to another, the hose shall be designed to handle both liquid and gaseous ammonia. Such hose shall be equipped with approved shutoff valves at the discharge end. Provision shall be made to prevent excessive pressure in hose.

4.1.6.3 Hose and hose connections located on the low-pressure side of flow control or pressure-reducing valves shall be designed for a bursting pressure of not less than 5 times the pressure setting of the safety relief devices protecting that portion of the system, but in any case it shall not be less than 863 kPa. All connections shall be so designed and constructed that there will be no leakage.

4.1.6.4 On all hoses of 12 mm outside diameter and larger, used for the transfer of anhydrous ammonia liquid or vapour, there shall be etched, cast, or impressed at 1.5 m intervals the following information:

- “Anhydrous Ammonia” kPa maximum working pressure, manufacturer's name or trademark, year of manufacture.
- In lieu of this requirement the same information may be contained in a nameplate permanently attached to the hose.

4.1.7 Safety relief devices shall comply with the Gulf Standard mentioned in item 2.1 and as follows:

4.1.7.1 Each container used in systems covered by items 4.2, 4.4, and 4.5 shall be equipped with safety relief valves of spring loaded type or equal.

4.1.7.2 Minimum required rate of discharge in cu.m/hr of air at 120 percent of the maximum permitted start-to-discharge pressure for safety relief valves to be used on container shall be determined as follows:

Flow rate cu.m/min. of air = $4.394A^{(.82)}$.

A = Total outside surface area of container in sq.m.

Flow rate = cu.m/min. of Air = Required flow capacity in cu.m/min. of air at standard conditions.

4.1.7.3 Each container safety - relief valve used with systems covered by items 4.2, 4.4 and 4.5, shall be plainly and permanently marked with the symbol "NH_3" or "Anhydrous Ammonia"; with the pressure in kPa at which the valve is set to start-to-discharge; the actual rate of discharge of the valve at its full open position in cu.m/min. of air at standard conditions; and the manufacturer's name and catalog number.

4.1.7.4 The flow capacity of the relief valve shall not be restricted by a connection to it on either the upstream or downstream side.

4.1.7.5 A hydrostatic relief valve shall be installed between each pair of valves in the liquid ammonia piping or hose where liquid may be trapped, so as to relieve it into the atmosphere at a safe location.

4.1.8 Filling Densities and Charging of Containers

4.1.8.1 The filling densities for containers that are not refrigerated shall not exceed the following:

Type of Container	Percent by Weight	Percent by Volume
Aboveground -- Uninsulated	56	82
Aboveground -- Insulated	57	83.5
Underground -- Uninsulated	58	85

4.1.8.2 Aboveground uninsulated containers may be charged 87.5 percent by volume provided that the temperature of the anhydrous ammonia being charged is determined to be not lower than $(-1)^{o}C$ or provided that the charging of the container is stopped at the first indication of frost or ice formation on its outside surface and is not resumed until such frost or ice has disappeared.

4.1.8.3 The filling density for refrigerated storage container shall be such that the container will not be liquid full at a liquid temperature corresponding to the vapour pressure at the start-to-discharge pressure of safety relief valve.

4.1.9 Transfer of liquid anhydrous ammonia shall comply with the Gulf Standard mentioned in item 2.1 and as follows:

4.1.9.1 Anhydrous ammonia shall always be at a temperature suitable for the material of construction and the design of the receiving container.

4.1.9.2 Pumps shall be designed for at least 1765 kPa working pressure.

- Positive displacement pumps shall have a constant differential relief valve discharging into the suction port of the pump through a line of sufficient size to carry the full capacity of pump at relief valve setting, such setting and installation shall be according to the pump manufacturer's recommendations.
- On the discharge side of the pump, before the relief valve line, there shall be installed a pressure gauge graduated from 0 to 2746 kPa.

– Plant piping shall contain shutoff valves located as close as practical to pump connections.

4.1.9.3 Compressors shall be designed for at least 1765 kPa working pressure.

4.1.9.3.1 Plant piping shall contain shutoff valves located as close as practical to compressor connections.

4.1.9.3.2 A relief valve large enough to discharge the full capacity of the compressor shall be connected to the discharge before any shutoff valve.

4.1.9.3.3 Compressors shall have pressure gauges at suction and discharge, graduated to at least 1 ½ times the maximum pressure that can be developed.

4.1.9.3.4 Adequate means, such as a drainable liquid trap, shall be provided on the compressor suction to minimize the entry of liquid into the compressor.

4.1.10 For tank car or transport truck loading or unloading points and operation, provisions of the Gulf Standard mentioned in item 2.1 shall apply.

4.1.11 Liquid level gauging devices shall comply with the Gulf Standard mentioned in item 2.1 and as follows:

4.1.11.1 A thermometer well shall be provided in all containers not utilizing a fixed liquid level gauging device.

4.1.11.2 Fixed tube liquid level gauges shall be designed and installed to indicate the level at which the container is filled to 85 percent of its water capacity.

4.1.12 Electrical equipment and wiring for use in ammonia installations shall be of the general purpose or weather resistant type as appropriate. Where the concentration of ammonia in air is in excess of 16 percent by volume, the area shall be designated as Class 1, Group D. Electrical systems shall be installed and maintained in accordance with the Gulf Standard mentioned in item 2.2.

4.1.13 Aboveground uninsulated containers shall have a reflective surface maintained in good condition.

4.1.14 Handling

4.1.14.1 Personnel required to handle ammonia shall be trained in safe operating practices and in the proper action to be taken in the event of emergencies.

4.1.14.2 All stationary storage installatins shall have at least two suitable gas masks in readily accessible locations. Full face masks with ammonia canisters are suitable for emergency action for most leaks, particularly those that occur outdoors. For protection in concentrated ammonia atmospheres, self-contained breathing air apparatus is required.

4.1.14.3 Stationary storage installations shall have an easily accessible safety shower and eye washer.

4.1.14.4 Each vehicle transporting anmonia in bulk shall carry a container of at least 19 litres of water and shall be equipped with a full face mask.

4.2 Nonrefrigerated Storage Containers, Stationary.

Item 4.1 applies to this item unless otherwise noted.

4.2.1 Design pressure for nonrefrigerated containers shall be minimum 1765 kPa.

4.2.2 Each filling connection shall be provided with a combination of back-pressure cheek valve and excess-flow valve; or with one double or two single back-pressure check valves; or a positive shutoff valve in conjunction with either an internal back-pressure check valve or an internal excess flow valve.

4.2.3 All liquid and vapour connections to containers except filling pipes, safety relief connections, and liquid level gauging and pressure gauge connections provided with orifices larger than 1.5 mm diameter shall be equipped with excess-flow valves.

4.2.4 Each storage container shall be provided with a pressure gauge graduated from 0 - 2746 kPa. Gauges shall be designed for use in ammonia service.

4.2.5 All containers shall be equipped with vapour return valves.

4.2.6 The rate of discharge of spring-loaded safety relief valves installed on underground containers may be reduced to a minimum of 30 percent of the rate of discharge calculated per formula in item 4.1.7.2. Containers so protected shall not be uncovered after installation until the liquid ammonia has been removed. Containers which may contain liquid ammonia before being installed underground and before being completely covered with earth are to be considered aboveground containers when determining the rate of discharge requirements of the safety-relief valves.

4.2.7 On underground installations where there is a probability of the manhole or housing becoming flooded, the discharge from vent lines shall be located above the high water level. All manholes or housings shall be provided with ventilated louvers or equivalent, with the area of such openings equalling or exceeding combined discharge areas of safety-relief valves and vent lines which discharge their content into the manhole housing.

4.2.8 Vent pipes, when used, shall not be restricted or of a diameter smaller than the relief-valve outlet connection.

4.2.9 If desired, vent pipes from two or more safety-relief devices located on the same unit, or similar lines from two or more different units may be run into a common discharge header, provided that the capacity of such header is at least equal to the sum of the capacities of the individual discharge lines.

4.2.10 Installation of storage container shall comply with the Gulf Standard mentioned in item 2. 1.

4.2.11 The distances between underground containers of over 7570 litres water capacity shall be at least 1.5 m.

4.2.12 Protection of appurtenances shall comply with the Gulf Standard mentioned in item 2. 1.

4.2.13 Ammonia systems shall be protected from damage by vehicles.

4.3 Refrigerated Storage System

This item applies to systems utilizing containers with the storage of anhydrous ammonia under refrigerated conditions. All applicable rules of item 4.1 shall also apply unless otherwise noted.

4.3.1 Design and construction of containers shall comply with the Gulf Standard mentioned in item 2.1 and as follows:

4.3.1.1 The design temperature shall be the minimum temperature in which the container will be refrigerated.

4.3.2 Installation of containers shall be according to applicable parts of the Gulf Standard mentioned in item 2. 1. Containers for product storage at less than $0^{o}C$ shall be supported in such a way, or heat shall be supplied, to prevent the effects of freezing and consequent frost heaving.

4.3.3 A check valve shall be installed on the fill connection and a remotely operated shutoff valve shall be installed on other connections located below the maximum liquid level.

4.3.4 Safety Relief Devices

4.3.4.1 Safety relief valves shall be set to start-to-discharge at a pressure not in excess of the design pressure of the container and shall have a total relieving capacity sufficient to prevent a maximum pressure in the container of more than 120 percent of the design pressure. Relief valves for refrigerated storage containers shall be self-contained spring-loaded, weight-loaded, or self-contained pilot-operated type.

4.3.4.2 The total relieving capacity shall be the larger of:

- Possible refrigeration system upset such as cooling water failure, power failure, instrument air or instrument failure, mechanical failure of any equipment, or excessive pumping rates.
- Fire exposure determined in accordance with good engineering practice. If the relieving capacity required for fire exposure is greater than that required by the previous item, the additional capacity may be provided by weak roof-to-shell seams in containers operating at essentially atmospheric pressure and having an inherently weak roof-to-shell seam. The weak roof-to-shell seam is not to be considered as providing any of the capacity required in the previous item.

4.3.4.3 If vent lines are installed to conduct the vapours from the relief valve, the back pressure under full relieving conditions shall not exceed 50 percent of the start-to-discharge pressure for pressure balanced valves or 10 percent of the start-to-discharge pressure for conventional valves. The vent shall be installed to prevent accumulation of liquid in the lines.

4.3.4.4 Valve installation shall be provided with weather protection.

4.3.4.5 Atmospheric storage shall be provided with vacuum breakers.

4.3.5 Protection of container appurtenances shall comply with the Gulf Standard mentioned in item 2. 1.

4.3.6 Ammonia systems shall be protected from damage by vehicles.

4.3.7 Refrigeration Load and Equipment

4.3.7.1 The total refrigeration load shall be computed as the sum of the following:

- Load imposed by heat flow into the container caused by the temperature differential between design ambient temperature and storage temperature.
- Load imposed by heat flow into the container caused by maximum sun radiation.
- Maximum load imposed by filling the container with ammonia warmer than the design storage temperature.

4.3.7.2 More than one storage container may be used by the same refrigeration system.

4.3.8 Compressors

4.3.8.1 A minimum of two compressors shall be provided, either of which shall be of sufficient size to handle the loads listed in item 4.3.7.1. Where more than two compressors are provided, minimum standby equipment equal to the largest normally operating equipment shall be installed. Filling compressors may be used as standby equipment for holding compressors.

4.3.8.2 Compressors shall be sized to operate with a suction pressure at least 10 percent below the minimum setting of the safety valve(s) on the storage container and shall withstand a suction pressure at least equal to 120 percent of the design pressure of the container.

4.3.8.3 Each compressor shall have its individual driving unit.

4.3.8.4 An emergency source of power of sufficient capacity to handle the loads listed in item 4.3.7.1 shall be provided unless facilities are available to safely dispose of vented vapours while the refrigeration system is not operating.

4.3.9 Automatic Control Equipment

4.3.9.1 The refrigeration system shall be arranged with suitable controls to govern the compressor operation in accordance with the load as evidenced by the pressure in the container(s).

4.3.9.2 An emergency alarm system shall be installed to function in the event the pressure in the container(s) rises to the maximum allowable operating pressure.

4.3.9.3 An emergency alarm and shutoff shall be located in the condenser system to respond to excess discharge pressure caused by failure of the cooling medium.

4.3.9.4 All automatic controls shall be installed in a manner to preclude operation of alternate compressors unless the control will function with the alternate compressors.

4.3.10 Separators for Compressors

4.3.10.1 An entrainment separator of suitable size and design pressure shall be installed in the compressor suction line of lubricated compressors. The separator shall be equipped with a drain and gauging device.

4.3.10.2 An oil separator shall be installed in the compressor discharge line. It shall be designed for at least 1765 kPa.

4.3.11 The condenser system may be cooled by air or water or both. The condenser shall be designed for at least 1765 kPa. Provision shall be made for purging noncondensible gases either manually or automatically.

4.3.12 A receiver shall be provided with a liquid-level control to discharge the liquid ammonia to storage. The receiver shall be designed for at least 1765 kPa and be equipped with the necessary connections, safety valves, and gauging devices.

4.3.13 Refrigerated containers and pipelines which are insulated shall be covered with a material of suitable quality and thickness for the temperature encountered. Insulation shall be suitably supported and protected against the weather. Weatherproofing shall be of a type which will not support flame propagation.

4.4 Motor Transportation of Ammonia

4.4.1 This item applies to containers and pertinent equipment mounted on tank motor vehicles including semitrailers and full trailers used for the transportation of ammonia. Item 4.1 applies to this item unless otherwise noted.

4.4.2 Design, construction, and marking of containers shall comply with the Gulf Standard mentioned in item 2.1 and as follows:

4.4.2.1 The shell or head thickness of any container shall not be less than 5 mm.

4.4.2.2 All container openings, except safety-relief valves, liquid level - gauging devices, and pressure gauges, shall be labelled to designate whether they connect into vapour or liquid space.

4.4.3 Container Appurtenances

4.4.3.1 All appurtenances shall be protected against physical damage.

4.4.3.2 All connections to containers, except filling connections, safety-relief devices, and liquid level and pressure gauge connections, shall be provided with suitable automatic excess flow valves, or in lieu thereof, may be fitted with quick-closing internal valves, which shall remain closed except during delivery operations. The control mechanism for such valves may be provided with a secondary control remote from the delivery connections. Such control mechanism shall be provided with a fusible section (melting point 97^{o}C to 104^{o}C) which permits the internal valve to close automatically in case of fire.

4.4.3.3 Filling connections shall be provided with automatic back-pressure check valves, excess-flow valves, or quick-closing internal valves, to prevent back-flow in case the filling connections are broken. Where the filling and the discharge connect to a common opening in the container shell and that opening is fitted with a quick-closing internal valve as specified in item 4.4.3.2, the automatic valve shall not be required.

4.4.3.4 All containers shall be equipped with spray loading (filling in the vapour space) or with an approved vapour return valve of adequate capacity.

4.4.4 Piping and fittings shall comply with the Gulf Standard mentioned in item 2.1 and as follows:

4.4.4.1 Means shall be provided to protect hose while the vehicle is in motion.

4.4.5 Any portion of liquid ammonia piping which at any time may be closed at both ends shall be provided with a thermal relief valve.

4.4.6 Transfer of Liquids

4.4.6.1 The content of tank motor vehicle containers shall be determined by weight, by a suitable liquid-level gauging device, or other methods. If the content of a container is to be determined by liquid-level measurement, the container shall have a thermometer well so that the internal liquid temperature can be easily determined.

4.4.6.2 Any pump, except a constant speed centrifugal pump, shall be equipped with a suitable pressure actuated bypass valve permitting flow from discharge to suction. Pump discharge shall also be equipped with a spring-loaded safety relief valve set at a pressure not more than 135 percent of the setting of the bypass valve or more than 2746 kPa whichever is larger.

4.4.6.3 Compressors shall be equipped with manually operated shut off valves on both suction and discharge connections. Pressure gauges of bourdon-tube type shall be installed on the suction and discharge of the compressor before the shut off valves. The compressor shall not be operated if the pressure gauge is either removed or inoperative. A spring-loaded, safety-relief valve capable of discharging to atmosphere the full flow of gas from the compressor at a pressure not exceeding 2060 kPa shall be connected between the compressor discharge and the discharge shut off valve.

4.4.6.4 Valve functions shall be clearly and legibly identified by metal tags or nameplates permanently affixed to each valve.

4.4.7 Full Trailers and Semitrailers

4.4.7.1 All full trailers shall be firmly and securely attached to the vehicle drawing them by means of suitable drawbars supplemented by a safety chain (or chains) or safety cables.

4.4.7.2 Every full trailer or semitrailer shall have a reliable system of brakes, and adequate provision shall be made to operate the brakes from the driver's seat.

4.4.7.3 Full trailers shall be so designed that the towed vehicle will follow substantially in the path of the towing vehicles and will not whip or swerve dangerously from side to side.

4.4.8 Motor Vehicles

4.4.8.1 Each tank motor vehicle shall be provided with properly attached bumpers or chassis extension arranged to protect the tank, piping, valves, and fittings from physical damage in case of collision.

4.4.8.2 At least two chock blocks shall be provided. These blocks shall be placed to prevent rolling of the vehicle whenever it is parked during loading and unloading operations.

4.4.8.3 When portable tank containers are used in lieu of cargo tanks and are permanently mounted on tank motor vehicles for the transportation of ammonia, they shall comply with the requirements of item 4.4.

4.5 Ammonia as a Refrigerant

4.5.1 Refrigerating Systems Classification by Type:

Refrigerating systems shall be divided into classes, descriptive of the method employed for extracting heat as follows:

4.5.1.1 Direct system is one in which the evaporator is in direct contact with the material or the space refrigerated or is located in air-circulating passages communicating with such spaces.

4.5.1.2 Indirect system is one in which a liquid, such as brine or water, cooled by the refrigerant, is circulated to the material or the space refrigerated or is used to cool air so circulated. Indirect systems which are distinguished by the type or method of application are as given in the following items.

4.5.1.3 Indirect open-spray system is one in which a liquid, such as brine or water, cooled by an evaporator, located in an enclosure external to a cooling chamber is circulated to such cooling chamber and is sprayed therein.

4.5.1.4 Indirect closed-surface system is one in which a liquid, such as brine or water, cooled by an evaporator located in an enclosure external to a cooling chamber, is circulated to and through such a cooling chamber in pipes or other closed circuits.

4.5.1.5 Indirect vented closed surface system is one in which a liquid, such as brine or water, cooled by an evaporator located in a vented enclosure external to a cooling chamber, is circulated to and through such cooling chamber in pipes or other closed circuits.

4.5.1.6 Double indirect vented open spray system is one in which a liquid, such as brine or water, cooled by an evaporator located in a vented enclosure, is circulated through a closed circuit to a second enclosure where it cools another supply of a liquid, such as brine or water, and this liquid in turn is circulated to a cooling chamber and is sprayed therein.

4.5.1.7 Double (or secondary) refrigerant system is one in which an evaporative refrigerant is used in a secondary circuit. For the purpose of this item each system enclosing a separate body of an evaporative refrigerant shall be considered as a separate direct system.

4.5.2 General Requirements

4.5.2.1 There shall be no restriction on quantity of ammonia used in refrigerant used at industrial location except as noted in item 4.5.2.2.

4.5.2.2 When the number of persons in a refrigerated space, served by a direct system, on any floor above the first floor (ground level or deck level) exceeds 1 person/10 sq.m of floor area, the following requirements shall apply unless that refrigerated space containing more than 1 person/10 sq.m of floor area above the first floor is provided with the required number of doors opening directly into approved building exits. Such refrigerated space shall be isolated from the rest of the building by tight construction with tight-fitting doors.

Note: The above does not prohibit openings for the passage of products from one refrigerated space to another refrigerated one.

4.5.2.3 Ammonia shall not be used for direct systems when the system is designed for air conditioning for human comfort. For other applications in sealed absorption

systems and self contained or unit systems the amount of ammonia shall be limited to 9 kg.

4.5.2.4 For indirect systems the maximum quantity of ammonia in machinery rooms shall be limited to 275 kg. There is no limit for class T-machinery rooms. Such systems shall be of indirect vented closed-surface, or double indirect vented open-spray, or primary circuit of double refrigerant type.

4.5.2.5 Each refrigerating machinery room shall be provided with tight-fitting door or doors and shall have no partitions or openings that will permit the passage of escaping refrigerant to other parts of the building.

Each refrigerating machinery room shall be provided with means of ventilation to the outer air. The amount of ventilation for refrigerant removal purposes shall be determined by the refrigerant content of the largest system in the machinery room as shown in the Table.

4.5.2.6 Any machinery room housing a refrigerating system shall have no flame-producing device or hot surface above 425^{o}C in such room and all electrical equipment shall be installed for Class 1, Group D, Division 2. (See the Gulf Standard mentioned in item 2.2).

4.5.3 Refrigerant piping, valves, fittings, and related parts used in the construction and installation of refrigerating systems shall conform to the Gulf Standard mentioned in item 2.1.

4.5.4 All systems containing more than 3 kg of refrigerant, other than systems utilizing non-positive displacement compressors, shall have stop valves installed.

4.5.5 Location of Refrigerant Piping

4.5.5.1 Refrigerant piping crossing an open space which affords passageway in any building shall be not less than 2.3 m above the floor unless against the ceiling of such space.

Table

Machinery Room Ventilation Requirements

Quantity of Ammonia Refrigerant in kilograms	Mechanical Discharge of Air in cu.m/min.	Quantity of Ammonia Refrigerant in kilograms	Mechanical Discharge of Air in cu.m/min.
10	5	1100	92
20	6	1200	97
30	8	1300	102
40	10	1400	107
50	12	1500	112
75	17	1600	118
100	21	1700	123
125	24	1800	129
150	27	1900	135
175	30	2000	140
200	33	2200	152
225	36	2400	163
250	39	2600	173
275	42	2800	184
300	45	3000	195
350	50	3500	221
400	54	4000	245
450	58	4500	268
500	61	5000	292
550	64	6000	329
600	67	7000	366
700	72	8000	400
800	77	9000	432
900	82	10000	460

Mechanical ventilation, when used, shall consist of power-driven exhaust fans which shall be capable of removing from the refrigerating machinery room the amount of air set forth in the Table. The inlet to the fan, or fans, or air duct connection shall be located near the refrigerating equipment. The outlet from the fan, or fans, or air duct connection shall terminate outside of the building.

Class T-Machinery Rooms in basements or subbasements shall have. as set forth in the Table. mechanical ventilation operating continuously.

4.5.5.2 Free passageway shall not be obstructed by refrigerant piping. Refrigerant piping shall not be placed in any elevator, dumbwaiter, or other shaft which has openings to main exit hallways. Refrigerant piping shall not be placed in public hallways, lobbies, or stairways, except that such refrigerant piping may pass across a public hallway if there are no joints in the section in the public hallway, and provided that non ferrous tubing be contained in a rigid metal pipe.

4.5.5.3 Refrigerant piping shall not be carried through floors except as follows:

– It may be carried from the basement to the first floor or from the top floor to a machinery penthouse or to the roof.

– For the purpose of connecting to a condenser on the roof, it may be carried through an approved, rigid and tight continuous fire-resisting pipe, duct or shaft having no openings on intermediate floors, or it may be carried on the outer walls of the building provided that it is not located in an air shaft, closed court, or in other similar open spaces enclosed within the outer walls of the building.

4.5.6 Design and Construction of Equipment

4.5.6.1 Every part of a refrigerating system with the exception of pressure gauges and control mechanisms, shall be designed, constructed, and assembled to be capable of withstanding a test pressure not less than the minimum refrigerant leak field test pressure without being stressed beyond one-third of its ultimate strength.

All materials used in the construction and installation of refrigerating systems shall be suitable for conveying the refrigerant, or the oil, or the combination of both.

4.5.7 Pressure Limiting Devices

Pressure-limiting devices shall be provided on all systems containing more than 9 kg of refrigerant and operating above atmospheric pressure, and on all water cooled systems so constructed that the compressor or generator is capable of producing a pressure in excess of the test pressure.

4.5.7.1 The maximum setting to which a pressure-limiting device may readily be set by use of the adjusting means provided shall not exceed 90 percent of the setting of the pressure-relief device, 90 percent of the refrigerant leak field test pressure actually applied, or 90 percent of the design working pressure of the high side of the system, whichever is smallest. The pressure-limiting device shall stop the action of the pressure-imposing element at a pressure not higher than this maximum setting.

4.5.7.2 Pressure limiting devices shall be connected with no intervening stop valves, between the pressure-imposing element and any stop valve on the discharge side.

4.5.7.3 Liquid level gauge glasses, except those of the bull's-eye or reflex type, shall have automatic closing shutoff valves, and such glasses shall be adequately protected against injury.

4.5.7.4 Dial of a pressure gauge when the gauge is permanently installed on the high side of a refrigerating system, shall be graduated up to approximately double the operating pressure, but in no case less than 1.2 times the design working pressure.

4.5.7.5 Each separately sold condensing unit and each compressor or compressor unit, sold for field assembly in a refrigerating system shall carry a nameplate marked with the manufacturer's name, trademark or trade name, identification number, and the name of the refrigerant for which it is designed.

4.5.8 Refrigerant-Containing Pressure Vessels

– Refrigerant-containing pressure vessels shall comply with the Gulf Standard mentioned in item 2.3.

– All pressure vessels, irrespective of size or pressure, shall be equipped with approved pressure relief devices.

4.5.9 Relief Devices in General

4.5.9.1 Every refrigerating system shall be protected by a pressure-relief device unless so constructed that pressure due to fire conditions will be safely relieved by some part of the system.

4.5.9.2 No stop valve shall be located between any automatic pressure-relief device or fusible plug and the part or parts of the system protected thereby, except when parallel relief devices are so arranged that only one can be rendered inoperative at a time for testing or repair purposes.

4.5.9.3 All pressure-relief devices shall be connected, as nearly as practicable, directly to the pressure vessel or other parts of the system protected thereby, above the liquid refrigerant level, and shall be installed so that they are readily acessible for inspection and repair and so that they cannot be readily rendered inoperative. Fusible plugs may be located above or below the liquid refrigerant level.

4.5.9.4 Each pressure vessel containing liquid refrigerant which may be shut off from other parts of the refrigeration system shall be protected by adequate relief devices as follows:

– Vessels of 0.3 cu.m or more gross volume shall be protected by two relief valves in parallel or one relief valve and a rupture member in parallel.

– Vessels of less than 0.3 cu.m gross volume shall be protected by one relief valve or rupture member.

Exceptions:

a. Pressure vessels of less than 7.5 cm inside diameter.

b. Pressure vessels used as evaporators and which are insulated or installed in an insulated space in sizes up to 15 cm inside diameter.

c. Pressure vessels used as evaporators and which are insulated or installed in an insulated space in sizes over 15 cm inside diameter may be installed with a single pressure relief device.

4.5.9.5 All pressure - relief devices and fusible plugs on refrigerating systems containing more than 3 kgs refrigerant shall safely discharge to the outside of the building either directly or through any line which in turn is protected by a relief device with discharge connection to the outside except as otherwise provided for in item 4.5.9.6. If discharge relief piping passes through an area with temperature low enough to cause condensation and freezing of moisture from the air, the discharge pipe shall be protected with a satisfactory seal.

4.5.9.6 Ammonia may discharge into a sanitary sewer system after mixing with water or may discharge into a tank of water which shall be used for no other purpose except ammonia absorption. At least 8.3 litres of fresh water shall be provided for every kg of ammonia in the system.

4.5.10 Field Tests

4.5.10.1 Every refrigerant-containing part of every system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gauges, and control mechanisms, that are factory tested, shall be tested and proved tight after complete installation, and before operation, at not less than the minimum refrigerant leak field test pressures in compliance with item 4.5.10.4.

Limited charge systems equipped with a pressure-relief device erected on the premises, shall be tested at a pressure not less than 1½ times the pressure setting of the relief device.

4.5.10.2 Oxygen or any combustible gas or combustible mixture of gases shall not be used within the system for testing.

4.5.10.3 The means used to build up the test pressure shall have either a pressure-limiting device or a pressure reducing device and a gauge on the outlet side.

4.5.10.4 Every refrigerant-containing part of every system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gauges, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.

The high or low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high or low side of the system, respectively.

4.5.11 Instructions

4.5.11.1 Each refrigerating system erected on the premises shall be provided with a legible permanent sign securely attached and easily accessible, indicating thereon the name and address of the installer, the kind and total weight of refrigerant required in the system for normal operations, and the refrigerant leak field test pressure applied.

4.5.11.2 Systems containing more than 50 kg of refrigerant shall be provided with metal signs having letters not less than 13 mm in height designating the main shutoff valves to each vessel, main steam or electrical control, remote control switch, and pressure-limiting device. On all exposed high pressure and low pressure piping in each room where installed outside the machinery room, shall have signs, as specified above, with the name of the refrigerant and the words “High Pressure” or “Low Pressure”.

4.5.11.3 It shall be the duty of the person in charge of the premises on which a refrigerating system containing more than 25 kg of refrigerant is installed, to place a card conspicuously as near as practicable to the refrigerant compressor giving directions for the operation of the system, including precautions to be observed in case of a breakdown or leak as follows:

– Instruction for shutting down the system in case of emergency.

– The name, address, and day and night telephone number for obtaining service.

– The name, address, and telephone number of the concerned authority having jurisdiction, and instructions to notify the said authority immediately in case of emergency.

4.5.11.4 Pressure gauges shall be checked for accuracy prior to an air test and immediately after every occasion of unusually high pressure, equal to full scale reading, either by comparison with master gauges or by getting the pointer as determined by a dead weight pressure gauge tester.

4.5.12 When refrigerant is added to a system, except a unit system requiring less than 2.7 kg of refrigerant, it shall be charged into the low pressure side of the system. Any point on the downstream side of the main liquid line stop valve shall be considered as part of the low pressure side when operating with said stop valve in the closed position. No service container shall be left connected to a system except while charging or withdrawing refrigerant.

4.5.13 Refrigerants withdrawn from refrigerating systems shall be transferred to approved containers only. No refrigerant shall be discharged to a sewer.

4.5.14 Containers used for refrigerants withdrawn from a refrigerating system shall be carefully weighed each time they are used for this purpose, and the containers shall not be filled in excess of the permissible filling weight for such containers and such refrigerants.

4.5.15 Refrigerant stored in a machinery room shall not be more than 20 percent of the normal refrigerant charged nor more than 150 kg of the refrigerant, in addition to the charge in the system and the refrigerant stored on a permanently attached receiver, and then only in approved storage containers.

4.5.16 Approved respiratory protective devices shall be provided and maintained in good condition in readily accessible containers or cabinets located immediately outside the compressor rooms. If more than 500 kg of such refrigerants are used in a system, at least two such approved respiratory protective devices shall be provided and maintained in good working condition.

4.5.17 Canisters shall be renewed immediately after having been used or the seal broken and if unused, they shall be renewed at least once every two years. The date of renewal shall be marked thereon.

4.5.18 All refrigerating systems shall be maintained by the user in a clean condition free from accumulations of oily dirt, waste, and other debris, and shall be kept readily accessible at all times.

4.5.19 Every cold storage room shall have at least one door which can be opened from the inside except as provided in item 4.5.22.

4.5.20 Illumination shall be provided in the room. This may be either a constantly burning lamp without switch control or a lamp controlled by a switch, to be located inside, near the door. If a switch is used, means shall be provided to indicate its location in the dark.

4.5.21 A fireman's type axe shall be kept in the room near the door.

4.5.22 Doors may be padlocked or otherwise securely locked from the outside if the room is equipped with an inside release mechanism which will release the latch and open the door when the latch is padlocked or,

There is posted on the outside of the door a sign reading, “Do Not Lock These Doors Until You are Positive No One is Inside”, and

The room is equipped with an electrically operated audible and visible signal system which can be actuated from inside the room and be seen and heard outside the room. Both systems have to be on a single control and tested daily.

4.2.23 Cold storage rooms cooled directly by refrigerant coils which are located inside the room and are subject to collision damage or by air mechanically circulated over refrigerant coil which are subject to damage shall have at least two exits remotely located from each other. These exits may be through ventilated corridors or other ventilated areas which provide unobstructed and safe access to a place of safety.

4.5.24 This Standard shall not apply to cold storage rooms having a floor area of less than 18 sq.m provided that an employee would not be required to travel more than 3 m to an interior operating exit door.